Application No. 10/790,403
Filed: March 1, 2004
TC Art Unit: 2822
Confirmation No.: 1449

REMARKS

Claims 1-31 are currently pending. Claims 1-12 and claims 27-31 have been withdrawn from prosecution. Claims 13-23 have been allowed. Claims 24-26 stand rejected under 35 U.S.C. § 112, second paragraph and §103(a). Claim 24 has been amended.

The Applicants respectfully request reconsideration of the pending application in view of the above amendment and for the following reasons. Withdrawal of the same is respectfully requested.

35 U.S.C § 112, SECOND PARAGRAPH REJECTIONS

Claims 24-26 stand rejected under 35 U.S.C. § 112, second paragraph as indefinite. Claim 24 has been amended. Accordingly, the Applicants believe that the grounds for rejection are now moot.

35 U.S.C § 103(a) REJECTIONS

Claims 24-26 stand rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. Patent Application Publication Number 2001/0032977 to Abe, et al. ("Abe") in view of U.S. Patent Number 6,335,231 to Yamazaki, et al. ("Yamazaki"). The Applicants respectfully traverse these rejections in view of the amendment to claim 24 and for the following reasons.

The invention as claimed discloses methods of fabricating a silicon photo-detector (claims 13-23, which have been allowed) and methods of <u>fabricating a buried reflective layer</u> in silicon

WEINGARTEN, SCHURGIN,
GAGNEBIN & LEBOVICI LLP
TEL. (617) 542-2290
FAX. (617) 451-0313

(claims 24-26, currently rejected). As provided in the Specification, the

> reflective layer provides for an enhance Fabry-Perot, resonant cavity response to incident light. The buried layer comprises **alternating silicon and silicon dioxide layers which form the distributed Bragg reflector** (DBR).

Specification, page 3, lines 14-18 (Emphasis added). A bottom DBR (14), as shown in FIG. 2 of the present invention, includes a silicon layer (18) sandwiched between silicon oxide layers (16). The DBR (14), further, underlies a silicon absorption region (12) through which incident light can travel. Such an arrangement, improves the detecting efficiency. See, e.g., Id., page 3, lines 22-26.

According to the teachings of the present invention (as recited in claim 24), an oxide layer (22) is grown on a first silicon body (20) (FIG. 3) and hydrogen atoms are implanted through the oxide layer (22) to form a thin, hydrogen ion layer (24) (FIG. 4A). The oxide layer (22) of the first silicon body is then thermally bonded to a surface of a second silicon body (26) and subject to a first heat treatment, causing the boundary between the hydrogen-implanted region (24) and the non-hydrogen-implanted region of the first silicon body (20) to cleave (FIG 5). The resulting product is shown in FIG. 6 and FIG. 8B.

To produce a DBR (14), an oxide layer (32) is grown on a third silicon layer (30) (FIG. 7) and hydrogen atoms are implanted through the oxide layer (32) to form a thin, hydrogen ion layer (34) (FIG. 8A). The oxide layer (32) of the third silicon layer (30) is then thermally bonded to the top silicon layer (28) of the second silicon body (26) (FIG. 6 or FIG. 8A) and subject to a heat

WEINGARTEN, SCHURGIN,
GAGNEBIN & LEBOVICI LLP
TEL. (617) 542-2290
FAX. (617) 451-0313

treatment. The heat treatment cleaves the hydrogen-rich ion layer (34) from the non-hydrogen-implanted region of the third silicon layer (30) (FIG. 9).

As shown in FIG. 10, the resulting DBR includes an upper silicon layer (34) an upper oxide layer (32) another silicon layer (28), a lower oxide layer (24), and then another silicon layer (26). See, e.g., Id., page 3, line 34 to page 4, line 35. Consequently, the silicon and silicon oxide layers alternate, e.g., silicon, silicon dioxide, silicon, silicon dioxide, silicon.

The Examiner concedes that Abe does not teach a process that includes heating the substrates to a cleaving temperature, asserting, however, that Yamazaki teaches a bonding process that includes the same. The Applicants respectfully disagree.

As previously (and persuasively) argued by the Applicants, the Abe reference does not teach, mention or suggest a first heating step to a cleaving temperature followed by a second heating step to a bond strengthening temperature. Abe merely teaches bonding a bond wafer to a base wafer at room temperature and annealing the wafers at a higher temperature. See, e.g., Abe, ¶¶ 0059, 0062, and 0063. Hence, Abe expressly teaches away from a two-step heating process for bonding a silicon surface to a silicon dioxide layer by first heating a hydrogen-implanted body in the silicon surface to a cleaving temperature, "to promote cleaving or fracturing of regions containing hydrogen from regions not containing hydrogen".

Yamazaki discloses essentially the same thing. More particularly, Yamazaki teaches fabricating a semiconductor device having an SOI substrate using a main surface of a crystal face of the {110} plane, to ensure very highly adhesive contact between a

WEINGARTEN, SCHURGIN,
GAGNEBIN & LEBOVICI LLP
TEL. (617) 542-2290
FAX. (617) 451-0313

single crystal silicon layer and an underlying insulating layer. See, e.g., U.S. Patent Number 6,335,231, col. 4, lines 27-32. Referring to Yamazaki FIGs. 1A-1F and the accompanying Embodiment 1 disclosure, at FIG. 1C, Yamazaki teaches bonding a silicon substrate 104 having a silicon oxide film 105 to the silicon oxide film of the single crystal silicon substrate 101. See, e.g., Id., col. 6, lines 1-5. According to Yamazaki,

> [a]t this time, since a bonding interface is formed of highly hydrophilic silicon oxide films, they are adhered to each other with hydrogen bonds by reaction of moisture contained in both the surfaces.

Id., col. 6, lines 12-15.

As a result, Yamazaki does not teach a buried layer comprising "**alternating silicon and silicon dioxide layers which form the distributed Bragg reflector** (DBR)." Id., page 3, lines 14-18 (Emphasis added). There is no alternating silicon and oxide layers as produced through the method of the invention as claimed. As shown in Yamazaki FIG. 1E, after cleaving the single crystal layer (101) from the hydrogen-rich region (106), Yamazaki has a single crystal layer (108), an oxide layer (102), another oxide layer (107), and a silicon layer (104). There is no silicon layer sandwiched between the two oxide layers. Nor would it have been obvious to do so using Yamazaki, which contains no reference to Applicants' unobvious outcome.

Indeed, neither Abe nor Yamazaki teaches a method of manufacturing a multilayered DBR at all. Hence, one of ordinary skill in the art trying to manufacture a multi-layered DBR would not have found at the time the invention was made Abe in combination with Yamazaki helpful to solve the problem solved.

WEINGARTEN, SCHURGIN,
GAGNEBIN & LEBOVICI LLP
TEL. (617) 542-2290
FAX. (617) 451-0313

Application No. 10/790,403
Filed: March 1, 2004
TC Art Unit: 2822
Confirmation No.: 1449

Accordingly, the Applicants believe that claims 24-26 are not made obvious by Abe in view of Yamazaki and, further, satisfy all of the requirements of 35 U.S.C. §§ 101, et seq., especially § 103(a). As such, the claims are in condition for allowance.

The Examiner is encouraged to telephone the undersigned attorney to discuss any matter that would expedite allowance of the present application.

Respectfully submitted,

M. SELIM UNLU ET AL.

By: ______________________
Charles L. Gagnebin III
Registration No. 25,467
Attorney for Applicant(s)

WEINGARTEN, SCHURGIN,
GAGNEBIN & LEBOVICI LLP
Ten Post Office Square
Boston, MA 02109
Telephone: (617) 542-2290
Telecopier: (617) 451-0313

CLG/mrb

355368.1